

A Preliminary Assessment of Subsidies of Water Consumption: A Case Study “United Arab Emirates”

*Mohammad I. Majdalawi**

ABSTRACT

Many countries in the world are suffering from water scarcity, especially in the Arab region. However, in the United Arab Emirates (UAE) the total quantity of water consumption is about 4654 million cubic meters in the year 2007, while the availability of renewable water is about 808 million cubic meters annually. These figures reflect the non sustainable use of water in a country that is suffering from water scarcity. This paper focuses on the economic perspective of water, subsidy policies at the macro level in United Arab Emirates. The results of this study show that the total value of subsidy in UAE is AED¹ (Arab Emirates Dirham) 7168 million per year. By applying suggested policies in water subsidy, the total reduction in water use is expected to reach 675 million cubic meters per year and the total money savings between AED 2765 to 8728 million per year depending on the chosen policies.

Keywords: Water Economic, Water Subsidy, Virtual Water, UAE.

INTRODUCTION

Water is one of the most important resources in the world; nevertheless many countries in the world are suffering from water scarcity especially in the Arab region due to aridity and semi-aridity conditions. There are fifteen Arab countries under the water poverty line; where the share of water quantity per person per year is less than 1000 cubic meters. However, United Arab Emirates (UAE) is not an exception (AOAD, 2007). In spite of the scarcity of water in this country; the average domestic water use per capita per day is between 525 and 600 liters (Regulation and Supervision Burou, 2009), while the average world use is about 200 liters

per capita per day (GLEICK, 1996). However, the use of water is not sustainable and abused. The reason behind this high water consumption may refer to the water subsidy strategy which is applied in the UAE. This paper focuses on the economic perspective of water use at the macro level in the UAE. In order to analyze the water consumption at the macro level, there are many factors such as: the efficiency use of water, social and environmental impact and the economic use of water that should be taken into consideration. At this macro level the subsidy policy of water will be analyzed in different sectors. This analysis will help propose strategies for water subsidy policy to conserve water resources and achieve water security.

These results will help formulate future water subsidy strategies in UAE and in any other country suffering from similar conditions.

Aim and objectives

The aim of this study was to investigate the

* Assistant Professor, Department of Agricultural Economics & Agribusiness Management, Faculty of Agriculture, University of Jordan, Amman, Jordan, Tel: +962 6 5355 000 ext: 22342. Email: m.majdalawi@ju.edu.jo
¹ 1 \$= 3.67 AED

Received on 16/9/2010 and Accepted for Publication on 26/10/2011.

performance of the applied subsidy policy of water and to verify the impact of suggested water subsidy strategies on the water use and water conservation in UAE.

To achieve this aim the following objectives will take place:

1. Analyzing the water tariff system for different sectors.
2. Estimating the real cost of water use of different water sources considering the environmental cost.
3. Estimating the amount of money paid as a subsidy for water through different aspects and analyzing this according to different possible scenarios of subsidy policies to estimate the drainage of money in each scenario.
4. Proposing suggested strategies of water subsidy and investigating their impacts on conserving water resources and saving money.
5. Suggesting strategies in food production which conserves water resources in United Arab Emirates.

Methodology

The researcher has tailored the following methodology to achieve the required aim of this study.

- Reviewing certain applied policies which are related to the tariff and water subsidy strategy in United Arab Emirates (UAE).
- Verifying the rate of tariff for different water sources considering the following:
 - The tariff of groundwater is the same as the rate of electricity which is paid by the farmers for pumping each cubic meter of ground water.
 - The tariff of desalinated water is the same as the tariff paid by the beneficiaries in different parts of UAE.
- The tariff of treated wastewater is free of charge.
- Estimating the cost of water from different water sources. The desalinated water is estimated depending on the real cost of the desalination

process. There is no considerable difference in the cost of water desalination among different emirates in UAE, so the cost of water desalination in Abu Dhabi (where Abu Dhabi is one of the emirates in UAE and it is the biggest one) is considered as a basic value in estimating the cost of water desalination for the other emirates.

To estimate the cost of withdrawal groundwater (fresh and brackish), two types of costs should be taken into consideration. The first one is the cost of electricity which is used for pumping water. The second one is the environmental cost of using this water as a national resource of water. This cost is crucial for consideration in order to save this source of water for the next generations. The estimation of the environmental cost of using the fresh ground water is considered to be the same as the real cost of desalinated water due to the fact that using fresh ground water could be substituted by desalinated water. While the cost of the brackish water is considered to be the same as the cost of the third stage of treated wastewater. This is because using the brackish water could be substituted by the third stage of treated wastewater, but the available quantities of the third stage of treated wastewater do not equal the pumped quantities of brackish water. This will affect the cost of the brackish water. However, the cost of the brackish water has two folds of cost: the first one comes from the environmental cost which is applied on the quantity of brackish water which is equal to the quantity of the third stage of treated wastewater and the second one comes from the cost of pumping the brackish water. As a result, the cost of the brackish water is the weighted average of the two costs of the brackish water.

The value of the subsidy of water is calculated by deducting the total cost of water from the total rate which is paid by the beneficiaries.

Estimating the drainage of money as a result of

applying the water subsidy strategy comparing it with the following scenarios:

- The subsidy policy aimed to subsidize the quantity of water which is equal to the quantity of renewable fresh water.
- The subsidy policy aimed to subsidize the quantity of water consumption for domestic use and within the world average consumption (200 L \ capita \ day) (GLEICK, 1996).
- The subsidy policy aimed to subsidize the quantity of water consumption to the level of water poverty line (1000 m³/ capita/ year (AOAD, 2007)).

Comparing the value of water productivity for different crops and suggesting the suitable strategy to conserve the water use and achieving food security by using virtual water concept.

Water Situation in UAE

In view of the fact that the analysis of economic perspective of water use at macro level depends on the real consumption of water in different sectors, this part will shed a light on the water consumption from different sources.

The highest quantity of water use is from ground water resource compared to desalinated water and treated wastewater. It is estimated that more than 2500 million cubic meters per year of used water is from ground water while the using of desalinated water is

about 1500 million cubic meters per year (MOEW, 2008). At the macro level, the agricultural sector has the highest level of water consumption which is about 41% of the total water consumption.

The UAE is treating wastewater and using it for amenity. This use of different water sources, except for the treated wastewater in agriculture, reflects the farmers refuse using treated wastewater in their farms. The available quantity of treated wastewater is not high compared to the other two water sources (ground water and Desalination); the quantity of treated wastewater is estimated about 463 million cubic meters per year (MOEW, 2008).

The total quantity of water consumption was about 4654 million cubic meters in 2007 in addition to 700 million cubic meters that are considered as losses (table 1) while the total population in that year was 4,488,000 (MOEW, 2008, MOE, 2008). From these two values the quantity of water per capita per year is calculated and is about 1192 m³. On the other side, the quantity of water per capita from natural resources is estimated for 180 cubic meters (Mohamed S. Alasam, 2009). The availability of water from natural sources (available in the nature and renewable) is about 808 million cubic meters annually (180 cubic meters per capita multiply by total population).

Table 1: The water consumption from different resources, by sectors in UAE, 2007

	Agricultural	Domestic & Industrial	Amenity	Forestry	Total
Groundwater	1837	115	48	694	2694
Desalination	94	1321	83	0	1498
Reclaimed Water	0	0	463	0	463
Total	1930	1436	594	694	4654
Losses					700
Source: Ministry of Environment and Water, 2008 www.dewa.gov.ae , www.fewa.gov.ae , www.rsb.gov.ae					

Analysis of Tariff and the Cost of Water

The policy of the government in United Arab Emirates is oriented indirectly to subsidize the water consumption. The tariff of water in all of the Emirates is less than the actual cost of producing this important resource, nevertheless the subsidy is also provided to subsidize the electricity use. The actual part of electricity subsidy is considered as another shape of water subsidy since the pumping of ground water in UAE is by using electricity. To analyze the policy of water subsidy the cost and tariff of both water and electricity will be analyzed in this part.

The operational and fixed costs of Electricity and Water companies have increased over the years, due to the growth of demand and changes in price level over time in the economy as a whole. The total annual cost of the water and electricity sector has increased, in nominal terms, from AED 3.8 billion per annum in 1999 to about AED 10 billion per annum in 2007; an average increase of 13% per annum over 8 years. The share of production

costs has gradually increased over time and now accounts for 63% of total sector costs. At present, transmission, distribution and supply costs make up 15% and 22% of total sector costs, respectively. Electricity costs have historically exceeded those of water; the gap between water and electricity costs is reducing. Currently, electricity and water account for 52% and 48% of total sector costs, respectively (Regulation and Supervision Bureau, 2009).

Electricity Cost and Tariff

All the Emirates in UAE subsidize the electricity; the tariff of electricity is different according to the level of consumption, water utilization and customers' nationality. The lowest tariff is in Abu Dhabi, it is between AED 0.03- 0.15 /KW while in other Emirates it is between AED 0.2-0.33 /KW (as shown in table 2).

The estimated cost of each kilowatt of electricity is 0.237 AED considering the operational and investment cost.

Table 2: The tariff and cost of Electricity in different Emirates (AED/KW)

	Abu Dhabi	Dubai	Northern Emirates
Cost	0.237	0.237	0.237
UAE National-Domestic (remote areas)	0.03		
UAE National-Domestic (other areas)	0.05	0.20-0.33	0.20-0.33
Non UAE National-Domestic	0.15	0.20-0.33	0.20-0.33
Commercial	0.15	0.20-0.33	0.20-0.33
Industrial	0.15	0.20-0.33	0.20
Government Establishments	0.15		0.33
Farms	0.03		

Source: www.dewa.gov.ae, www.fewa.gov.ae, www.rsb.gov.ae and Regulation and supervision Bureau, 2009.

Water Cost and Tariff

In United Arab Emirates there are three main water sources; desalinated water, ground water and treated wastewater. This part will analyze the tariffs and the real

costs of water from different sources.

Tariff of Water

All sources of water are offered free of charge for the customers except the desalinated water. The tariff of

desalinated water differs according to the Emirate and the nationality of costumers. In Abu Dhabi the Tariff is between free -for the UAE nationality citizens- up to

AED 2.2 per cubic meter, while in other emirates it is about AED 6.6 per cubic meter (table 3).

Table 3: The tariff and cost of water in different Emirates AED/m³

	Desalinization	G. water ⁽¹⁾		T. wastewater		
		fresh	brackish	2 stage	3 stage	4 stage
Cost of water AED/m ³	7.3	0.43 ⁽²⁾ 7.3 ⁽³⁾	0.43 ⁽²⁾ 0.53 ⁽³⁾	0.7	1.25	2.25
Tariff of water AED/m ³						
Dubai	6.6	0.11 ⁽³⁾	0.11 ⁽⁴⁾	free	free	free
North Emirates	6.6	0.11 ⁽³⁾	0.11 ⁽⁴⁾	free	free	free
Abu Dubai Nat.	free	0.11 ⁽³⁾	0.11 ⁽⁴⁾	free	free	free
Abu Dubai non Nat.	2.2	0.11 ⁽³⁾	0.11 ⁽⁴⁾	free	free	free
Source: www.dewa.gov.ae , www.fewa.gov.ae , www.rsb.gov.ae , Regulation and supervision Bureau 2009 and International Center for Biosaline Agriculture, 2009. (1) Tariff and cost of ground water were estimated by the researcher.(2) Real cost (the cost of electricity). (3) Environmental cost. (4) The tariff of the ground water is considered as the tariff of electricity estimated per cubic meter.						

As the ground water extracts freely with no fees or tariff, it means the government subsidizes directly the withdrawals of this water. The tariff of ground water is considered in this research to be equal to the cost paid by farmers for pumping a cubic meter of ground water which is mainly considered the tariff of the electricity; it is estimated per cubic meter as in the following steps:

- Calculating the total value of electricity paid by farmers depending on the results of a survey conducted in different Emirates in 2009 by International Center of Biosaline Agriculture (ICBA).
- Calculating the average value of electricity per donum¹.
- Estimating the total value of electricity for all agricultural areas in all Emirates.

¹ Donum = 0.1 ha

- Dividing the total cost of electricity by total quantity of ground water consumed by agricultural sector.

As a result the value of electricity paid by farmers was found to be AED 0.11 per cubic meter. This value is considered –for purposes of the analysis- the tariff for one cubic meter of groundwater.

The Real Cost of Water Use

The real cost of water use is different for different water sources; for desalinated water it is estimated depending on the real cost of the desalination process. As the difference in the cost of desalinated water among different Emirates varies slightly, the cost of water desalination in Abu Dhabi is considered similar as for the other emirates, which is about AED 7.3 per cubic meter (table 3).

To estimate the cost of withdrawal ground water, two kinds of cost are considered in the analysis of ground water subsidy. The first one is the cost of electricity which is used for pumping water. The second one is the environmental cost of using this water as a national resource; since everyone has the right to use it and at the same time, there is a need to conserve this resource for the next generation.

The real cost of electricity used for pumping ground water is estimated depending on the value of electricity from a survey in 2009 (conducted by ICBA), from this value the quantity of consumed electricity in the farm is identified by dividing this value by the tariff of electricity. The total real value of electricity is calculated by multiplying this value by the real cost of the kilowatt and then followed by the previous steps in calculating the tariff of ground water per cubic meter which were mentioned above to find the real cost of pumping cubic meter of ground water. The value of the real cost of ground water is estimated about AED 0.43 per cubic meter.

As a result, the environmental cost of fresh ground water, which is considered the same as the cost of desalinated water, is calculated as AED 7.3 per cubic meter and the environmental cost for brackish water, which is considered the same as the cost of third stage of treated wastewater, is AED 1.25 per cubic meter (see table 3). Since the quantity of brackish groundwater is much higher than the treated wastewater, which is only 13.5% of the quantity of brackish water, then the cost is estimated as a weighted average of the value of the environmental cost for the quantity of treated wastewater and the real cost of the quantity of brackish water. As a result the estimated cost of ground water is AED 0.53 per cubic meter.

Analysis of Water Subsidy

The subsidy is the difference between what the customers really pay, depending on the tariff of cubic

meter, and the real cost (the cost and the tariff of water for different water sources are discussed in the previous part). The subsidy of water for each sector is calculated by deducting the total cost paid by customers from the total real cost of water. Table 4 shows the value of subsidy of water in different sectors in different Emirates. The highest value of subsidy of water is for Domestic and Industrial sector which reaches AED 4964 million AED. The Agricultural sector is the second one in the value of subsidy and is estimated at about AED 1053 million. This value is calculated depending on the estimation of subsidy of electricity. If the environmental cost of using ground water is considered in the analysis, the value of subsidy for agriculture sector will be about AED 1233 million. The total value of subsidy in all UAE and for all sectors is very high which reaches AED 7168 million.

Analysis of Water Use and Subsidy of Water Overused

UAE is suffering from the scarcity of water; however this problem is increasing by time as the population is increasing (Environment Agency Abu Dhabi, 2009). Since water resources are limited, policies must be oriented to conserve these resources.

The Value of Subsidy of Water and Water Overused

The total value of subsidy is AED 7168 million per year. The total subsidy of desalinated water is about AED 5709 million per year and of ground water is about 851 million AED per year while the total subsidy of treated wastewater is about AED 578 million per year. If the environmental cost of using ground water is considered, then the value of subsidy of ground water will be AED 1134 million per year. This means that the weighted average of water subsidy per cubic meter is about AED 1.53, while the value of subsidy per cubic meter of desalinated water is AED 3.8 and for cubic meter of the ground water is AED 0.32 AED.

Table 4 The cost and the value of subsidy of water in different Emirates, 2007 (million AED)

Emirate	Agriculture	Domestic / Industrial	Amenity	Forestry
Abu Dhabi				
Real Cost	1136.5	6043.12	593.79	258
Value paid by customers	281.6	1457.06	91.74	66
Value of subsidy	854.9	4586.06	502.05	192
Dubai				
Real Cost	90.215	2417.6	427.75	40.42
Value paid by customers	63.305	2180.2	214.5	10.34
Value of subsidy	26.91	237.4	213.25	30.08
Sharjah				
Real Cost	84.28	747.2	107.5	40.42
Value paid by customers	21.56	664.4	0	10.34
Value of subsidy	62.72	82.8	107.5	30.08
RAS Al Khimah				
Real Cost	85.14	180.36	26.25	0
Value paid by customers	21.78	159.72	0	0
Value of subsidy	63.36	20.64	26.25	0
Ajman				
Real Cost	11.18	225.02	27.5	0
Value paid by customers	2.86	199.54	0	0
Value of subsidy	8.32	25.48	27.5	0
UM Al Queen				
Real Cost	12.04	6.45	5.625	0
Value paid by customers	3.08	1.65	0	0
Value of subsidy	8.96	4.8	5.625	0
Fujeirah				
Real Cost	37.84	73	16.25	0
Value paid by customers	9.68	66	0	0
Value of subsidy	28.16	7	16.25	0
Total				
Real Cost	1457.195	9692.75	1204.665	338.84
Value paid by customers	403.865	4728.57	306.24	86.68
Value of subsidy	1053.33	4964.18	898.425	252.16

Source: calculated by researcher depending on tables 1, 2& 3

The term of water overused subsidy here refers to the subsidy value of the water quantity that exceeds the limit of the quantity which is aimed by the subsidy policy. To estimate the drainage of money which subsidizes the overuse of water three scenarios are considered as three possibilities reasons for subsidy policy (as discussed in the methodology), the analysis of these scenarios are as follows:

1. The value of subsidy of overuse water in case the subsidy policy aimed to subsidize the quantity of consumed water from natural resources and renewed yearly is AED 6909 million per year which is about 96% of the total subsidy.

2. If the subsidy policy aimed to subsidize the quantity of water consumption for domestic use reaches the level of the average of world water consumption (200 L/capita/day) then the total desalinated water quantity could be subsidized under this assumption which is 328 million cubic meters per year, then the value of subsidy of overuse water subsidy is 5922 million AED per year which is about 83% of the total subsidy.

3. If the subsidy policy aimed to subsidize the quantity of water consumption to the level of water poverty line (1000 m³/ capita/ year), then the total quantity of water could be subsidized under this scenario is 4488 million cubic meters per year, then the value of subsidy of overuse water is AED 1279 million per year which is about 18% of the total subsidy.

From the above scenarios, it is shown that the UAE subsidizes the overused of water for at least 18% of the total value of the subsidy of water which encourages the inefficient and abuse of this resource.

Suggested Strategies of Water Subsidy and their Impacts

The total value of subsidy, as estimated in the previous part, is about AED 7168 million. Sustainable water security could be achieved if the resources of

water are conserved and the efficiency of water use is increased. The average quantity of water consumed is about 1192 cubic meters per capita per year which exceeds 192 cubic meters; more than 1000 cubic meters per capita per year (water poverty line). Also, this quantity exceeds 997 cubic meters per year more than the share of capita per year of the natural water resources available in this country which is estimated about 180 cubic meters per capita per year.

This discussion leads to two suggested strategies to identify the tariff of water:

- The first strategy is to subsidize the level of water quantity that covers the required needs of people (Water Poverty Line - 1000 m³ per capita per year). This means 1000 cubic meter per person per year is subsidized while the over used quantity will be charged at the real cost of the resource. As there are three different resources with different costs the suggestion is to identify the percent of the quantity which can be subsidized from the total consumed quantity. The percent of this quantity is equal to:

$$(1000/1192) * 100\% = 84\%.$$

The new tariff (T*) will be calculated depending on the formula:

$T^* = T \times 84\% + C \times 16\%$, while T: Current tariff, C: Real cost of cubic meter.

Depending on this formula the tariff of desalinated water is found to be between AED 3.0- 6.7 per m³.

- The second suggested strategy is to subsidize only the level of water available as a natural resource. It means 180 cubic meters per capita per year are subsidized while the other quantities will be charged at the real cost of the resource. As there are three different resources with different costs, the suggestion is to identify the percent of the quantity which can be subsidized from the total consumed quantity (as in the first suggested policy). The percent of this quantity is

equal to: $(180/1192) \times 100\% = 15\%$.

The new tariff (T^*) will be calculated depending on the formula:

$T^* = T \times 15\% + C \times 85\%$, while T: Current tariff, C: Real cost of cubic meter.

Depending on this formula the tariff of desalination water is found to be between AED 6.5-7.2 per m^3 .

- Since the water tariff is also a political decision and depending on many factors and priorities in the country, the above suggested strategies could be applied in two steps to raise the tariff of water, or could be considered as two different scenarios for identifying the new tariff if the government finds there is a necessary need to subsidize the water.

- Since there are no specific tariff for ground water and treated wastewater, the following scenarios are suggested:

For ground water two options have been suggested; the first one is to charge the difference between the cost of electricity per cubic meter paid by farmers which is estimated in this paper (AED 0.11 / m^3) and the real cost (AED 0.43 / m^3). This means the tariff of each cubic meter of water will be AED 0.32. The second option is to consider the environmental cost of this resource. In this case two different costs have to be considered; the first one is for the fresh ground water which is replaced by desalinated water and the cost is considered the same as the cost of desalination (7.3 AED plus the cost of electricity which is 0.32 AED). The second one is for brackish ground water which could be as an alternative to the treated wastewater then the cost is 1.25 AED/ m^3 plus the value of electricity subsidy (AED 0.32 / m^3).

For the treated wastewater there are also two different cases; the cost of the third stage and the cost of the fourth stage of treating wastewater. The tariff of the third stage could be calculated by the difference between the cost of the second stage and the third stage because the

second stage is treated to solve environmental problems that might occur from the wastewater and not for the use of irrigation. The third stage of treating wastewater is safe to use for agriculture but farmers refuse to use it (as showed in table 1 no use for treated wastewater in agriculture), then the difference of the cost between third stage and fourth stage is considered as social cost. Since the third and fourth stages are done to be acceptable for irrigation -technically and socially- the tariff of the fourth stage is suggested to be the value of the difference between the second and fourth stage. According to the previous suggestions, the tariff of the third stage treating wastewater is 1.25 minus 0.7 which is equal AED 0.55 per cubic meter (the cost of second treating is estimated depending on the ratio between the cost of the third and fourth stage considering the cost of second stage in other countries). The fourth stage tariff is 2.25 minus 0.7 which is equal to AED 1.55 per cubic meter.

The Impact of the Suggested Tariff

In the last part two suggestions of tariff have been estimated; one is to subsidize the level of water quantity that covers the requirement of water for people (1000 m^3 per capita per year) in this case the tariff is low and it is considered, in this analysis, as Minimum Limit Tariff. The second one is to subsidize only the level of water available from the natural resource (180 m^3 per capita per year); in this case the tariff is high and is considered as High Limit Tariff. To identify the impact of applying the suggested tariffs, the following parts have been analyzed.

The Impact of Scenario 1: Minimum Limit Tariff

The proposed tariffs of the different resources of water in this scenario are:

- The tariff of desalinated water is AED 3.0- 6.7 per m^3 .
- The tariff of ground water is AED 0.32 per m^3 .
- The tariff of third stage treated wastewater is

AED 0.55 per m³, this tariff is more than the ground water tariff. Since the farmers refused using the third stage treated wastewater, the expectation impact of the suggested tariff will be as not using this water for irrigation. For this reason the tariff of the third stage is considered half of the suggested tariff for the analysis purposes with value of AED 0.27 per m³ (to be less than the tariff of groundwater).

In this scenario the expected impact is the reduction of consumption of desalinated and ground water and partly using the treated wastewater for irrigation. For the purpose of quantifying the impact of this scenario it is assumed that:

- The total supply of water is the same as before applying of this scenario.
- The expectation of using water is the reduction in using both desalinated and groundwater by 10% of the present use depending on the elasticity of water, considering the elasticity demand of water is less than 0.5 (Abu Qdais H.A.; 2001)
- Depending on the elasticity of water as 0.5% about 5% of third stage of treated wastewater is expected to be used for agriculture and replacing it using ground water.

The impact of this scenario on conserving the water resources will be as follows:

1. The expected reduction in quantity of the desalinated water will be from 1498 to 1348 million cubic meters per year.
2. The expected reduction in quantity of the ground water will be from 2694 to 2402 million cubic meters per year.
3. The total reduction of water quantity is expected to be 442 million cubic meters per year.
4. The saving of money which is paid as subsidy for desalinated water, is AED 1907 million. This value is calculated depending on the quantity of expected

demand for water and the weighted average of the tariffs. This means saving the subsidy of desalinated water will be less by about 33%.

5. The saving of money that is paid as subsidy for electricity is used for pumping the ground water and is estimated at AED 851 million, since the value of the new tariff is equal to the value of electricity subsidy.

6. The saving of money of subsidy of treated wastewater is 5.3 million AED.

7. The total saving is 2765 million AED which is about 39% of the total value of the subsidy.

The Impact of Scenario 2: Up Limit Tariff

The proposed tariffs of the different resources of water in this scenario are:

- The tariff of desalinated water is AED 6.5-7.2 per m³.
- The tariff of ground water is AED 7.62 per m³ for fresh water and AED 1.57 per m³ for brackish water. Since the quantity of fresh ground water is small comparing with the brackish groundwater the value of tariff is assumed to be AED 1.57 per m³ (tariff of brackish water).
- The tariff of the third stage treated wastewater is AED 0.55 per m³.

In this scenario the expected impact is the reduction in consumption of desalinated water and groundwater by using more treated wastewater than that in scenario 1. For the purpose of quantifying the impact of this scenario, it is assumed that:

- The total supply of water is the same as before applying this scenario.
- The expectation of using both desalinated and ground water will be reduced by 15% of the current use (depending on the elasticity of water 0.5%),
- 10% of third stage of treated wastewater will be used for agriculture and replacing using groundwater (depending on the elasticity of water

0.5%),

The impact of this scenario on conserving the water resources will be as follows:

1. The expected quantity of desalinated water will be reduced from 1498 to 1273 million cubic meters per year.
2. The expected quantity of ground water will be reduced from 2694 to 2244 million cubic meters per year.
3. The total reduction in quantity of water is expected to be 675 million cubic meters per year.
4. The saving in subsidy for desalinated water is estimated at AED 5047 million. This value is calculated depending on the quantity of expected water demands and the weighted average of the tariffs. This means that the subsidy savings of desalinated water will be less by about 88%.
5. The saving of money for ground water subsidy is equal to that paid as subsidy for electricity used for pumping the ground water, which is AED 851 million in addition to the value of environmental cost, which is AED 2805 million. The total value of saving subsidy is AED 3656 million per year.
6. The saving of money for subsidy of treated wastewater is AED 25 million per year.
7. The total saving is found to be AED 8728 million which is more than the total cost of different water sources (because in this analysis the environmental cost

is considered).

Policies of water use in Agriculture - food and water security

The importance of agriculture sector comes from the role of this sector in achieving food security. This sector has the highest level of consumption of water, which in return will affect negatively on achieving water security. In this part two parameters will be considered. The first one is the virtual water which will reflect the quantity of water needed to produce one unit of the product. This parameter will give an idea which crop could be cultivated in this country to maximize the efficient use of water. The other parameter is the value of the unit of the product for each cubic meter of water. This parameter compares the value of product and the real cost of each cubic meter.

Table 5 shows the water requirements for main crops in Emirates. It is clear from this table that Dates and Alfalfa are the highest water consumption but at the same time the ranking of these crops should consider the productivity. The same is applied for the animal products which appear in table 6. The virtual water for the plant production is calculated depending on the production and the quantity of water. The virtual water content of different animals for most countries was calculated by Chapagain and Hoekstra (2003) as explained in table 6.

Table 5: Production, area and water requirement for the main crops in UAE, 2007

products	Production (Thousand Tons)	Area (Donum)	Value (Thousand Dirham)	Water requirements (m ³ /donum)
Vegetables	148.5	36,018	238,557	670
Dates	757.6	1,853,295	1,983,067	2000
Fruits	32.5	22,467	118,323	1020
Alfalfa	222.4	227,391	254,665	1570

Source: Ministry of Environment and Water, 2008 and Environment Agency Abu Dhabi, 2009

Table 5 shows the water requirements for main crops in Emirates. It is clear from this table that Dates and Alfalfa are the highest water consumption but at the same time the ranking of these crops should consider the productivity. The same is applied for the animal products which appear in table 6. The virtual water for

the plant production is calculated depending on the production and the quantity of water. The virtual water content of different animals for most countries was calculated by Chapagain and Hoekstra (2003) as explained in table 6.

Table 6: Production, value and virtual water of animals in UAE, 2007

Animals Production	Production (Thousand Tons)	Value (Thousand Dirham)	Virtual Water m ³ / ton
Meat	4.4	75,803	6342
Poultry Meat	29.4	307,268	1904
Milk & Milk Production	346.4	1,385,420	12149
Eggs	25.3	192,198	1968

Source: Environment Agency Abu Dhabi, 2009

Figure 1 shows the virtual water of different crops and animal products. It is obvious that the milk and meat production and the Dates are the highest content of virtual water. This means that exporting these products means exporting high quantities of water. The policy must be oriented to produce these products only to the level of achieving food security. It is not necessary to achieve self

sufficiency from these products if there is any alternative safe source to import the quantity needed for local consumption. In all cases the production of these products must be for the domestic needs. This means the pattern of production must be changed to the plant or animal production with low content of virtual water, which will lead to the conservation of water resources.

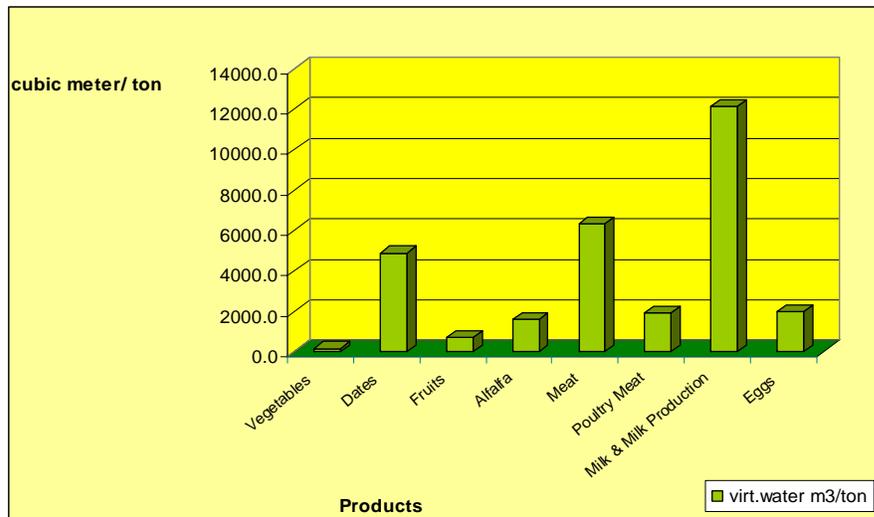


Figure 1: virtual water of different crops and animals

Figure 2 shows the value of products per cubic meter. These values of different crops and animal productions emphasize the results of virtual water. Vegetables are the highest value per cubic meter which is about 10 AED per Kg, but the lowest values are for Alfalfa, Dates and milk production and all of them are less than 1 AED per cubic meter. This means that the value of these products per unit of water is less than the average value of subsidy of water

applied by the government which is estimated in this paper to be about 1.53 AED. This reflects that from both economic and water security perspectives, these products must be changed to other products that consume less water and the value of production per cubic meter of water is higher.

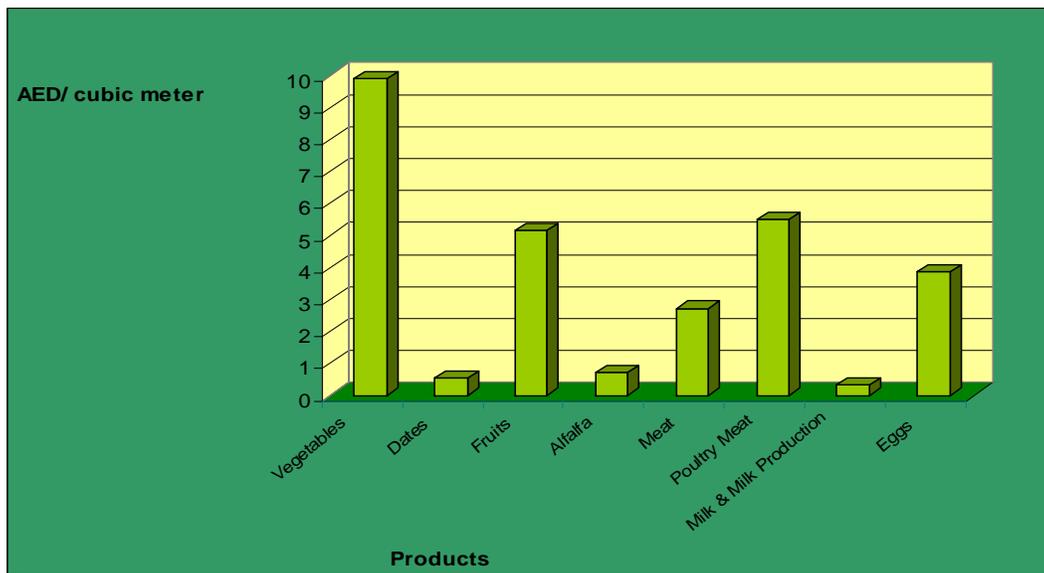


Figure 2: Value of production per unit of water

Conclusions and Recommendations

1. Subsidy of Water:

The total value of water subsidy in all UAE and for all sectors reaches 7168 million AED per year. The weighted average of subsidy of water is about AED 1.53 per cubic meter. The value of subsidy per cubic meter of desalinated water is AED 3.8 and for cubic meter of round water is AED 0.32 AED.

2. The Value of Subsidy of Water Overused

To estimate the value of water subsidy which subsidizes the overuse of water, three scenarios are considered as three possibilities reasons for subsidy policy. The results show:

- The value of subsidy of overuse water in case the subsidy policy aimed to subsidize the quantity of consumed water from natural resources and renewed yearly is about 96% of the total subsidy.
 - The value of subsidy of overuse water subsidy is about 83% of the total subsidy if the subsidy policy aimed to subsidize the quantity of water consumption for domestic use up to the level of the average of world water consumption (200 L/capita/day).
 - The value of subsidy of overuse water subsidy is about 18% of the total subsidy if the subsidy policy aimed to subsidize the quantity of water consumption to the level of water poverty line (1000 m³/capita/year).

- The total quantity of water could be subsidized under this scenario to 4488 million cubic meters per year, and then the value of subsidy of overuse water is AED 1279 million per year which is about 18% of the total subsidy.

3. Suggested strategies and expected impacts:

- Two polices have been suggested to identify the tariff of desalinated water:

1. To subsidize up to the limit of water quantity that covers the minimum required needs of people (Water poverty line). In this case the suggested tariff of desalinated water is between AED 3.0- 6.7 per m³.

2. To subsidize up to the limit of water quantity that is renewable yearly. In this case the tariff of desalinated water is between AED 6.5-7.2 per m³.

- Two polices have been suggested to identify the tariff of ground water:

1. To charge the difference between the cost of electricity per cubic meter paid by farmers and the real cost. The suggested tariff of each cubic meter of water is AED 0.32.

2. To charge the estimated value of environmental cost of this resource. In this case two different costs have to be considered; the first one is for fresh ground water which is 7.3 AED plus AED 0.32 as the cost of electricity. The second one is for brackish ground water which is 1.25 AED/m³ plus the value of electricity subsidy.

- Two tariff have been suggested for treated wastewater:

1. For third stage treated wastewater is suggested to be the difference between the cost of the second stage and third stage because the second stage is treated to solve environmental problems that might occur from the wastewater. The suggested tariff of the third stage is equal to AED 0.55 per cubic meter.

2. For the fourth stage, the tariff of is suggested to be the value of the difference cost between the second and fourth stage. It is estimated to be AED 1.55 per cubic meter.

- According to the previous suggestions, two limits of impact are expected:

1. Minimum Impact: In this case the following is expected:

- The total reduction of water quantity is 442 million cubic meter per year.

- The total reduction in the value of subsidy is 2765 million AED which is about 39% of the total value of the subsidy.

2. Maximum Impact: In this case the following is expected:

- The total reduction of water quantity is 675 million cubic meter per year.

- The total reduction in the value of subsidy is AED 8728 million which is more than the total cost of different water sources.

4. Food security and Water security

- The milk and meat production and the Dates are the highest content of virtual water. This means that the exportation of these products is exporting high quantities of water.

- Vegetables are the highest value of products per cubic meter which is about 10 AED but the lowest values are for Alfalfa, Dates and milk production and all of them are less than 1 AED per cubic meter. This means that the value of these products per unit of water is less than the average subsidy of water applied by the government, which is estimated in this paper about 1.53 AED.

This reflects that from both the economic and water security perspectives, these products must be changed to produce other products which consume less water and the value of production per cubic meter is higher.

REFERENCES

- Abu Qdais H.A.; Al Nassay H.I., 2001 , “Effect of pricing policy on water conservation: a case study” Water Policy, Volume 3 (3), Publisher: Elsevier, pp. 207- 214(8), www.waterpolicy.net
- AOAD-Arab Organization for Agricultural Development, 2007, Training of trainers’ course “Water Awareness in Mashreq Region”, Khartoum sudan.
- Chapagain and Hoekstra, A.Y., 2003, Virtual Water Trade, IHE Delft Rept. No. 12, pp. 13-23.
- Environment Agency Abu Dhabi 2009, Report of “Abu Dhabi Water Resources Master Plan”, Abu Dhabi, United Arab emirates.
- International Center for Biosaline Agriculture (ICBA), 2009, Abu Dhabi Strategy for wastewater Reuse, Dubai- UAE.
- GLEICK, P., 1996, Basic water requirements for human activities: Meeting basic needs. International Water 21(2):pp. 83-92.
- Ministry of Economy (MOE) - Central Statistical Department, 2007, Annual Social and Economic Report, United Arab Emirates.
- Ministry of Environment and Water (MOEW) 2008, Evaluation of Water Resources in UAE-Current Situation and Future demand, Water Budget Model, Dubai, United Arab Emirates.
- Mohamed S. Alasam. 2009, Desalination and Water Environment in the United Arab Emirates: Impacts and Solutions Workshop, International Desalination World Congress –Dubai- UAE.
- Regulation and Supervision Bureau for the Water, 2009, 2008 Annual Report, Wastewater and Electricity Sector in the Emirate of Abu Dhabi, UAE.
- <http://www.dewa.gov.ae/tariff/tariffdetails.aspx>, visited at 26 Jan 2010
- http://www.fewa.gov.ae/index_en.html, visited at 26 and 27 2010
- http://www.rsb.gov.ae/En/PrimaryMenu/index.aspx?CatMenu_ID=67&CatMenu_Name=Tariffs&PriMenu_, visited at 28 Jan. 2010

4654
808

675

7168

8728 -2765

2007

.2011/10/26

2010/9/16